

## 2.4 DETAILED RESULTS FOR SIGNATURE FLUCTUATIONS

Several discrepancies were found in the glint portion of the Signature Fluctuations Functional Element (FE) for ESAMS 2.6.2. Some problems are due to the fact that the flag KFIRST remains equal to one for several passes through Subroutine GLINT. This produces incorrect angle rates of change and uncorrelated values of error due to glint. Another discrepancy involves the calculation of the body length and wing length, as projected into the azimuth (yaw) direction. This should be done without incorporation of the sine-elevation cofactor (see BDM white paper “The Question of ELENGY” [2]). An additional concern is that one of the factors in the glint correlation coefficient is computed using the system time step while the correlation coefficient itself is computed using one-half of the system time step. Finally, a software test uncovered a problem where an error is introduced into the calculation of angle rates of change due to the use of single precision numbers when small numbers are involved.

The quality of the code for the Fluctuation FE in ESAMS 2.6.2 is generally good, but a few improvements were recommended. The internal documentation is adequate but could also be improved. External documentation for ESAMS 2.5 is adequate for this FE as implemented in ESAMS 2.6.2.

The table listed below summarizes the desk-checking and software testing verification activities for each subroutine in the Signature Fluctuations Functional Element. The two results columns contain checks if no discrepancies were found. Where discrepancies were found, the desk check results column contains references to discrepancies listed in Table 2.4-4, while the test case results column lists the number of the relevant test case in Table 2.4-6. More detailed information on the results is recorded in these tables.

TABLE 2.4-1. Verification Matrix for Signature Fluctuations.

Design Element	Code Location	Desk Check Result	Test Case ID	Test Case Result
4-1 Geometry	GLINT 165-239	D1	4-1,2,3 4,5,8	4-1 4-2
4-2 Glint Half-Power Frequency	GLINT 245-249		4-6	
4-3 Glint Error and Target Position	GLINT 264-346	D2	4-7,8,9 10	4-8 4-9
4-4 Exponential Draw	SINTL8 30-36 EXPDRW		4-11	
4-5 Chi-square with Four Degrees of Freedom Draw	SINTL8 36-42 CHIDRW		4-12	
4-6 Time Correlation	COREL8		4-13	

### 2.4.1 Overview

As a moving target changes its aspect relative to the radar, variations or fluctuations in the echo signal will result. ESAMS addresses two forms of signal fluctuations that induce both amplitude and angle noise. The magnitude of the amplitude noise (referred to as scintillation), which may affect the detection capabilities of the radar, is determined by altering the radar cross-section (RCS) value. The simulation approach used is to have the user select either an exponential draw, to represent Swerling cases 1 and 2, or a chi-square (four degrees of freedom) draw, to represent Swerling cases 3 and 4. Once the altered RCS value has been calculated, it is correlated with the prior value. The magnitude of the angle noise (referred to as glint) affects the apparent location of the target. Glint is modeled as a correlated Gaussian process, with standard deviation equal to one-fourth of the target angular size and correlation coefficient given by an exponential time decay. The time constant of this decay is proportional to the aspect rate of change of the target.

ESAMS 2.6.2 implementation of Signature Fluctuations is accomplished with five primary subroutines. Subroutine GLINT performs the glint portion of signature fluctuations. Subroutines CHIDRW, CORLE8, EXPDRW, and SINTL8 perform the scintillation portion of signature fluctuation. The five subroutines used for this FE are described in Table 2.4-2.

TABLE 2.4-2. Signature Fluctuations Subroutine Descriptions.

Module Name	Description
CHIDRW	Performs a chi-square (four degrees of freedom) draw using the RCS as the mean
CORLE8	Correlates a value with a previous value using the previous time, current time, and the correlation time from the common block PROGC
EXPDRW	Takes the mean value passed in as an argument, and performs the exponential draw
GLINT	Calculates glint to find apparent target position
SINTL8	Alters the RCS value to simulate the scintillation effect by calling on the desired probability density function

### 2.4.2 Verification Design Elements

Design elements defined for the Signature Fluctuations FE are listed in Table 2.4-3; they are fully described in Section 2.4.2 of ASP II. A design element is an algorithm that represents a specific component of the FE design. Design elements 4-1 through 4-3 compute fluctuations due to glint. Design element 4-4 computes scintillation using the exponential draw method. Design element 4-5 computes scintillation using the chi-square method. Design element 4-6 correlates current and previous scintillation coefficients.

TABLE 2.4-3. Signature Fluctuations Design Elements.

Subroutine	Design Element	Description
GLINT	4-1 Geometry	Calculation of geometrical aspects of the target with respect to the radar
GLINT	4-2 Glint Half-Power Frequency	Calculation of half-power frequency, based on target rotation rate and span as well as radar wavelength
GLINT	4-3 Glint Error and Target Position	Calculation of the correlated glint error and apparent (corrupted) target position, based on the standard deviation of glint error
SINTL8 EXPDRW	4-4 Exponential Draw	Calculation of a draw from a negative exponential distribution
SINTL8 CHIDRW	4-5 Chi-square with Four Degrees of Freedom	Calculation of a draw from a chi-square distribution with 4 degrees of freedom
COREL8	4-6 Time Correlation	Calculation of a new, correlated RCS value based on current scintillated value, previous value, and time difference

### 2.4.3 Desk Checking Activities and Results

The code implementing this FE was manually examined using the procedures described in Section 1.1 of this report. Discrepancies discovered are described in the following tables.

TABLE 2.4-4. Desk Checking Discrepancies.

Design Element	Desk Check Result
4.1 Geometry	D1: The calculations of ELNGWY and ELNGBY incorrectly include the sin(ELEV) co-factor. See BDM white paper entitled "The Question of ELENGY" [2].
4.3 Glint Error and Target Position	D2: In calculating the correlation coefficient for glint, the simulation time step is divided by 2 before use in Equation [2.4-7] of ASP II.

Except as noted in Table 2.4-5 below, overall code quality and internal documentation were evaluated as good. Subroutine I/O and logical flow were found to match the ASP II descriptions.

TABLE 2.4-5. Code Quality and Internal Documentation Results.

Subroutine	Code Quality	Internal Documentation
CHIDRW	OK	1. Add “square” after chi on line 6 and 11. 2. Does not have list of subroutines called.
COREL8	OK	Does not have list of subroutines called.
EXPDRW	OK	Does not have list of subroutines called.
GLINT	Code is overly complicated.	Header lacks description of routine and references. The definition of HPOWER, i.e., half-power angle of noncircular <u>target</u> , should read noncircular <u>beam</u>
SINTL8	OK	Does not have list of subroutines called.

#### 2.4.4 Software Test Cases and Results

Specific verification tests for the Signature Fluctuations FE are listed in Table 2.4-6. ESAMS was run in the debug mode with breakpoints set at the lines indicated so that variable values could be examined.

TABLE 2.4-6. Signature Fluctuations Test Cases.

Test Case ID	Test Case Description
4-1	<p>OBJECTIVE: Check initializations and Static Site-Target Geometry Calculations in Subroutine GLINT.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, and observe the value of KFIRST (initialized) at the first call to GLINT for the simulation run.</li> <li>2. Observe execution path following line 153.</li> <li>3. Observe the initialized values of GLNTWY(ITAR), GLNTWP(ITAR), GHPWRY, and GHPWRP.</li> <li>4. Continue execution, and observe the values of XTS, YTS and ZTS.</li> <li>5. Observe the values of XTGT, YTGT, and ZTGT returned from Subroutine GYRATE at line 173.</li> <li>6. Observe the values of RNGXY, RNGXYZ, and ELEV.</li> <li>7. Observe the value of AZIM at 185.</li> <li>8. Observe the execution path following line 194.</li> <li>9. Observe the value of ELOLD and AZOLD at lines 196 and 197.</li> <li>10. Continue execution until GLINT is entered again and observe the value of KFIRST.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of KFIRST observed in Step 1 equals one.</li> <li>2. Execution transfers to line 155 in Step 2.</li> <li>3. The values observed in Step 3 equal zero.</li> <li>4. The values observed in Step 4 equal independent calculation of the first three expressions in ASP II Equation [2.4-1].</li> <li>5. The values observed in Step 6 equal independent calculation of the first 3 expressions of ASP II Equation [2.4.2].</li> <li>6. The values observed in Step 7 equal independent calculation of the last expression of ASP II Equation [2.4.2].</li> <li>7. Execution transfers to line 196 in Step 8.</li> <li>8. The value of ELOLD observed in Step 9 equals the value of ELEV observed in Step 8.</li> <li>9. The value of AZOLD observed in Step 9 equals the value of AZIM observed in Step 8.</li> <li>10. The value of KFIRST observed in Step 10 is not equal to one.</li> </ol> <p>RESULT: At Step 10, KFIRST still equals one. This creates some serious problems; see Tests 4-2, 4-8, and 4-9. Otherwise OK.</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-2	<p>OBJECTIVE: Verify Angular Rates of Change Algorithm.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, and observe the values of ELEV, AZIM, ELOLD, AZOLD, and GDT before execution of line 202 after more than one call to Subroutine GLINT.</li> <li>2. Observe the values of ELEVR and AZIMR at line 202 and 203, respectively.</li> <li>3. Observe the values of ELOLD and AZOLD at line 206 and 207, respectively.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of ELEVR observed in Step 2 matches independent calculation of <math>\dot{r}</math> in ASP II Equation [2.4-3].</li> <li>2. The value of AZIMR observed in Step 2 matches independent calculation of <math>\dot{r}</math> in ASP II Equation [2.4-3].</li> <li>3. The value of ELOLD observed in Step 3 matches the value of ELEV observed in Step 1.</li> <li>4. The value of AZOLD observed in Step 3 matches the value of AZIM observed in Step 1.</li> </ol> <p>RESULT:</p> <ol style="list-style-type: none"> <li>1. Since KFIRST = 1 in several successive calls to GLINT, values for ELOLD and AZOLD are reinitialized to the current ELEV and AZIM. Thus, the angular rates are zero for several time steps.</li> <li>2. ESAMS was run until KFIRST = 1 to check the calculation of the angular rates of change. In these cases, there was a 20% to 28% error in the ESAMS calculated values for ELEVR and AZIMR compared to independent calculations. Some off-line tests were run to confirm this and it was found to be caused by the use of single precision numbers when small numbers are involved. The effect is compounded here because small numbers are subtracted from one another.</li> </ol>
4-3	<p>OBJECTIVE: Verify Algorithm for Calculating Effective Wing and Body Length.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, stop in Subroutine GLINT and observe the values of WLENG, BLENG, AZIM, and ELEV before execution of line 211.</li> <li>2. Observe the values of ELNGWY and ELNGBY at line 211 and 213, respectively.</li> <li>3. Observe the values of ELNGWP and ELNGBP at lines 227 and 229, respectively.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of ELNGWY observed in Step 2 matches independent calculation of <math>L_{W_y}</math> in ASP II Equation [2.4-4].</li> <li>2. The value of ELNGBY observed in Step 2 matches independent calculation of <math>L_{B_y}</math> in ASP II Equation [2.4-4].</li> <li>3. The value of ELNGWP observed in Step 3 matches independent calculations of <math>L_{W_p}</math> in ASP II Equation [2.4-4].</li> <li>4. The value of ELNGBP observed in Step 3 matches independent calculations of <math>L_{W_{B_p}}</math> in ASP II Equation [2.4-4].</li> </ol> <p>RESULT: OK</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-4	<p>OBJECTIVE: Verify Algorithm for Determining Effective Target Length in Yaw.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"><li>1. Run ESAMS, stop in Subroutine GLINT and observe the values of ELNGWY and</li><li>2. Deposit a value into ELNGWY that is greater than ELNGBY.</li><li>3. Observe the execution path to variable ELENGY after line 215.</li><li>4. Observe the value of ELENGY.</li><li>5. Repeat Step 1.</li><li>6. Deposit a value into ELNGWY that is less than ELNGBY.</li><li>7. Repeat steps 3 and 4.</li></ol> <p>VERIFY:</p> <ol style="list-style-type: none"><li>1. Execution transfers to line 217 in Step 3.</li><li>2. The value of ELENGY observed in Step 4 equals the value of ELNGWY from Step 2.</li><li>3. Execution transfers to line 221 in Step 7.</li><li>4. The value of ELENGY observed in Step 7 equals the value of ELNGBY from Step 6.</li></ol> <p>RESULT: OK</p>
4-5	<p>OBJECTIVE: Verify Algorithm for Determining Effective Target Length in Pitch.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"><li>1. Run ESAMS, stop in Subroutine GLINT and observe the values of ELNGWP and</li><li>2. Deposit a value into ELNGWP that is greater than ELNGBP.</li><li>3. Observe the execution path to variable ELENGP after line 231.</li><li>4. Observe the value of ELENGP.</li><li>5. Repeat Step 1.</li><li>6. Deposit a value into ELNGWP that is less than ELNGBP.</li><li>7. Repeat steps 3 and 4.</li></ol> <p>VERIFY:</p> <ol style="list-style-type: none"><li>1. Execution transfers to line 233 in Step 3.</li><li>2. The value of ELENGP observed in Step 4 equals the value of ELNGWP from Step 2.</li><li>3. Execution transfers to line 237 in Step 7.</li><li>4. The value of ELENGP observed in Step 7 equals the value of ELNGBP from Step 6.</li></ol> <p>RESULT: OK</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-6	<p>OBJECTIVE: Verify Calculation of Glint Half-Power Frequency Described in Design Element 4-2.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, stop in Subroutine GLINT and observe the values of XLNMIN,</li> <li>2. Observe the values of GHPWRY and GHPWRP at lines 248 and 249, respectively.</li> <li>3. Deposit a value into GHPWRY and GHPWRP that is less than the value of XLNMIN before execution of another line of code.</li> <li>4. Observe the values of GHPWRY and GHPWRP immediately after execution of line</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of GHPWRY and GHPWRP match independent calculation <math>\epsilon_y</math> of and <math>\epsilon_p</math>, respectively, of ASP II Equation [2.4-5].</li> <li>2. The values of GHPWRY and GHPWRP observed in Step 4 equal the value of</li> </ol> <p>RESULT: OK</p>
4-7	<p>OBJECTIVE: Verify Assignment of Field of View to Half-Power Beamwidths as Described in Design Element 4-3.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, stop in Subroutine GLINT and observe the initialization of ICIRC,</li> <li>2. Observe the value of FOVRAD immediately before execution of line 264.</li> </ol> <p>VERIFY:</p> <p>If the value of ICIRC observed in Step 1 equals zero, the value of FOVRAD equals</p> <p>RESULT: OK</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-8	<p>OBJECTIVE: Verify Computation of Correlated Glint Error in Yaw (Azimuth).</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, stop in Subroutine GLINT and observe the value of GLNTWY(ITAR)</li> <li>2. Continue execution until the next call to GLINT, stop and observe the value of XTS, YTS, ZTS, DTN, GLNTWY(ITAR), GHPWRY, and ELENGY before execution of line 263.</li> <li>3. Observe the value of RTS at line 264.</li> <li>4. Observe the value of SIGGY and RHOGY at line 275 and 277, respectively.</li> <li>5. Observe the value of SIGMAY and GLINTY at line 286 and 288, respectively.</li> <li>6. Observe the value of GLNTWY at line 290.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of GLNTWY(ITAR) in Step 2 matches that in Step 1.</li> <li>2. The value of RTS observed in Step 3 matches independent calculation of the last expression of ASP II Equation [2.4-1].</li> <li>3. The value of SIGGY observed in Step 4 matches independent calculation of ASP II Equation 2.4-6].</li> <li>4. The value of RHOGY observed in Step 5 matches independent calculation of ASP II Equation [2.4-7].</li> <li>5. The value of SIGMAY observed in Step 5 matches independent calculation of ASP II Equation [2.4-8].</li> <li>6. The value of GLINTY observed in Step 5 matches independent calculation of ASP II Equation [2.4-9].</li> <li>7. The value of GLNTWY observed in Step 6 equals that of GLINTY observed in Step 5.</li> </ol> <p>RESULT: As long as KFIRST = 1, the value of GLNTWY(ITAR) is reset to 0 at the beginning of GLINT; thus, the value at Step 2 does not equal the value at Step 1 and the value of GLINTY in Step 6 is actually uncorrelated. Continuing to run the model for many time steps eventually produces KFIRST = 0. This led to correct results in all steps.</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-9	<p>OBJECTIVE: Verify Computation of Correlated Glint Error in Pitch (Elevation Angle)</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, stop in Subroutine GLINT and observe the value of GLNTWP(ITAR) at line 318.</li> <li>2. Continue execution until the next call to GLINT, stop and observe the values of GLNTWP(ITAR), RTS, GHPWRP, and ELENGP before execution of line 300.</li> <li>3. Observe the value of SIGGP and RHOGP at line 303 and 305, respectively.</li> <li>4. Observe the value of SIGMAP and GLINTP at line 314 and 316, respectively.</li> <li>5. Observe the value of GLNTWP at line 318.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The values of GLNTWP(ITAR) in Step 2 matches that in Step 1.</li> <li>2. The value of SIGGP observed in Step 3 matches independent calculation of ASP II Equation 2.4-6].</li> <li>3. The value of RHOGP observed in Step 3 matches independent calculation of ASP II Equation [2.4-7].</li> <li>4. The value of SIGMAP observed in Step 4 matches independent calculation of ASP II Equation [2.4-8].</li> <li>5. The value of GLINTP observed in Step 4 matches independent calculation of ASP II Equation [2.4-9].</li> <li>6. The value of GLNTWP observed in Step 5 equals that of GLINTP observed in Step 3.</li> </ol> <p>RESULT: As long as KFIRST = 1, the value of GLNTWP(ITAR) is reset to 0 at the beginning of GLINT; thus, the value at Step 2 does not equal the value of Step 1 and the value of GLINTP in Step 4 is actually uncorrelated. Continuing to run the model for many time steps eventually produced KFIRST = 0. This led to correct results in all steps.</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-10	<p>OBJECTIVE: Verify calculation of apparent target position due to glint effects.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, and observe the values of EPSILN, GLINTP, XTS, YTS, ZTS, RTS, XSJ, YSJ, GLINTY, and ZSJ before execution of line 323.</li> <li>2. If the absolute values of XTS and YTS both are greater than or equal to the value of EPSILN, continue with Step 3; otherwise allow program execution to continue until a subsequent call to Subroutine GLINT yields both XTS and YTS to be greater than or equal to the value of EPSILN.</li> <li>3. Observe the value of AZPOS and ELPOS at lines 323 and 333, respectively.</li> <li>4. Observe the value of ELCOR and AZCOR at line 338 and 339, respectively.</li> <li>5. Observe the value of XTGAPP, YTGAPP, and ZTGAPP at lines 342, 343, and 344, respectively.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. If the value of AZPOS observed in Step 3 matches independent calculation of <math>a</math> of ASP II Equation [2.4-10].</li> <li>2. If the value of ELPOS observed in Step 3 matches independent calculation of the first expression for <math>q_c</math> in ASP II Equation [2.4-10].</li> <li>3. The value of ELCOR observed in Step 4 matches independent calculation of <math>c</math> of ASP II Equation [2.4-11].</li> <li>4. The value of AZCOR observed in Step 4 matches independent calculation of <math>c</math> of ASP II Equation [2.4-11].</li> <li>5. The value of XTGAPP observed in Step 5 matches independent calculation of <math>X_{Tapp}</math> of ASP II Equation [2.4-12].</li> <li>6. The value of YTGAPP observed in Step 5 matches independent calculation of <math>Y_{Tapp}</math> of ASP II Equation [2.4-12].</li> <li>7. The value of XTGAPP observed in Step 5 matches independent calculation of <math>Z_{Tapp}</math> of ASP II Equation [2.4-12].</li> </ol> <p>RESULT: OK</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-11	<p>OBJECTIVE: Verify Calculation of Scintillation using Exponential Draw (Subroutines SINTL8 and EXPDRW).</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Set the user input switch "XSCINT" to a value of 1.1 (to activate an exponential draw). Run ESAMS, and observe the value of ISCTFL and RCSVAL initialized in Subroutine SINTL8 (called by TGTRCS).</li> <li>2. Observe the value of ISCTFL at line 28.</li> <li>3. Observe the path of execution after line 30.</li> <li>4. Observe the call to Subroutine EXPDRW, noting the initialization of input argument RCSVAL.</li> <li>5. In Subroutine EXPDRW, observe the value of RA at line 27, and the value of REXP at line 29.</li> <li>6. In Subroutine SINTL8, observe the function value of EXPDRW.</li> <li>7. Observe the value of REXP and RCSVAL at line 32 and 34, respectively.</li> <li>8. Observe the value of RCS returned from SINTL8 to TGTRCS at line 83.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of ISCTFL observed in Step 2 equals 1.</li> <li>2. Execution transfers to line 32 in Step 3.</li> <li>3. The value of RCSVAL observed in Step 4 equals that of Step 1.</li> <li>4. The value of REXP observed in Step 5 matches independent calculation of ASP II Equation [2.4-13].</li> <li>5. The value of EXPDRW observed in Step 6 equals the value of REXP observed in Step 5.</li> <li>6. The value of REXP, RCSVAL (Step 7), and RCS (Step 8) equals the value of EXPDRW observed in Step 6.</li> </ol> <p>RESULT: OK</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-12	<p>OBJECTIVE: Verify Calculation of Scintillation using a Chi-Square with Four Degrees of Freedom Draw (Subroutines SINTL8 and CHIDRW).</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Set the user input switch "XSCINT" to a value of 2.1 (to activate chi-square four draw). Run ESAMS, and observe the value of ISCTFL and RCSVAL initialized in Subroutine SINTL8 (called by TGTRCS).</li> <li>2. Observe the value of ISCTFL at line 28.</li> <li>3. Observe the path of execution after line 30.</li> <li>4. Observe the call to Subroutine CHIDRW, noting the initialization of input argument MEANVL.</li> <li>5. In Subroutine CHIDRW, observe the value of RA and RB at line 28 and 29, respectively.</li> <li>6. Observe the value of X1 and Y1 at lines 31 and 32, respectively.</li> <li>7. Observe the value of RA and RB at lines 34 and 35, respectively.</li> <li>8. Observe the value of X2 and Y2 at lines 37 and 38, respectively.</li> <li>9. Observe the value of RCHI at line 40.</li> <li>10. In Subroutine SINTL8, observe the function value of CHIDRW.</li> <li>11. Observe (in SINTL8) the value of RCHI and RCSVAL at line 38 and 40,</li> <li>12. Observe the value of RCS returned from SINTL8 to TGTRCS at line 83.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of ISCTFL observed in Step 2 equals two.</li> <li>2. Execution transfers to line 36 followed by line 38 in Step 3.</li> <li>3. The value of MEANVL observed in Step 4 equals the value of RCSVAL observed in Step 1.</li> <li>4. The value of X1 and Y1 observed in Step 6 matches independent calculation of <math>\sigma_1</math> and <math>\sigma_2</math> of ASP II Equation [2.4-14] (using the values of RA and RB from Step 5).</li> <li>5. The value of X2 and Y2 observed in Step 8 matches independent calculation of <math>\sigma_3</math> and <math>\sigma_4</math> of ASP II Equation [2.4-14] (using the values of RA and RB from Step 7).</li> <li>6. The value of RCHI observed in Step 9 matches independent calculation of ASP II Equation [2.4-15]. The value of CHIDRW (Step 10), RCSVAL (Step 11), and RCS (Step 12) equals the value of RCHI observed in Step 9.</li> </ol> <p>RESULT: OK</p>

TABLE 2.4-6. Signature Fluctuations Test Cases. (Contd.)

Test Case ID	Test Case Description
4-13	<p>OBJECTIVE: Verify Calculation of Correlation Coefficient and weighted New Correlated RCS Value.</p> <p>PROCEDURE:</p> <ol style="list-style-type: none"> <li>1. Run ESAMS, and freeze execution when variable CORCOF is computed at line 31 of Subroutine COREL8 when called by Subroutine TGTRCS.</li> <li>2. Observe the values of CURTIM, OLDTIM, CORTIM, CORCOF, and CURVAL at line 31.</li> <li>3. Observe the value of CURVAL and OLDVAL at line 38.</li> <li>4. Observe the value of CURVAL returned to Subroutine TGTRCS.</li> </ol> <p>VERIFY:</p> <ol style="list-style-type: none"> <li>1. The value of CORCOF observed in Step 2 matches independent calculation of ASP II Equation [2.4-16] using the other values observed in Step 2.</li> <li>2. The value of CURVAL observed in Step 3 matches independent calculation of ASP II Equation [2.4-17] using the values observed in Step 2.</li> </ol> <p>RESULT: OK</p>

## 2.4.5 Conclusions and Recommendations

### 2.4.5.1 Code Discrepancies

In general, the scintillation portion of the Signature Fluctuations FE was found to be implemented as specified in Section 2 of ASP II; however, several discrepancies were found in the GLINT subroutine.

The variable KFIRST is described as a flag indicating the first pass through the subroutine; when KFIRST = 1, variables designed to hold values from the previous pass through GLINT are set to 0. Since KFIRST = 1 for many passes through GLINT, these variables are incorrectly set to 0, so values from the previous pass are lost. This leads to incorrect results for angle rates of change and to uncorrelated values of the errors due to glint.

In addition to the KFIRST errors, the equations used to calculate the effective wing and body length in yaw (azimuth), should not include the cofactor of sine of the elevation angle. Also, the glint correlation coefficient is computed using the system time step in one place and one-half of the system time step in another place.

Single precision numbers used in the calculation of AZIMR and ELEVR cause erroneous results. An error of 28% was observed in a test case. It is recommend that the variables ELEV, ELOLD, AZIM, AZOLD, AZIMR, ELEVR and GDT be converted to double precision.

### 2.4.5.2 Code Quality and Internal Documentation

The quality of the code for the scintillation portion of the Signature Fluctuations FE in ESAMS 2.6.2 is generally good; however, the code in Subroutine GLINT is overly complicated. Restructuring this subroutine is recommended.

Internal documentation is generally good, but a few minor deficiencies were found in some of the headers; a description of the routine and a list of references were omitted in some subroutines.

### **2.4.5.3    *External Documentation***

There is no external documentation for ESAMS 2.6.2. Therefore, the external documentation for ESAMS 2.5 was used. The *User's Manual* [3] explains that the flag RNOISE must be set in PROGC for signal fluctuation activation. The *Analyst's Manual* [4] contains an adequate explanation of glint and scintillation effects.

